BITS-Pilani, Hyderabad Campus: Course Description

M.E. Civil – Transportation Engineering

(For the most updated information, please refer to the latest Bulletin)

Year	First Semester			U	Second Semester			U
I	CE	G534	Pavement Material Characterization/ Core Course	4	CE	G568	Traffic System Analysis/ Core Course	4
	CE	G567	Highway Design/ Core Course	4	CE	G518	Pavement Analysis and Design	4
	CE	G565	Transportation Planning/ Core Course	4	BITS	G540	Research Practice	4
			Elective 1	4			Elective 3	4
			Elective 2	4			Elective 4	4
				20				**20**
II	BITS	G629T	Dissertation Or Elective Elective Elective Elective	16(min) 16(min)	BITS	G629T	Dissertation or Practice School	16 Or 20
				16(min)				**16/ 20**

Core Courses:

- CE G518 Pavement Analysis and Design 4
- CE G534 Pavement Material Characterization 4
- CE G565 Transportation Planning 3 1 4
- CE G566 Public Transportation 3 1 4
- CE G567 Highway Design 3 1 4
- CE G568 Traffic Systems Analysis 3 1 4

Elective Courses (any six):

- BITS F494 Environmental Impact Assessment 3 1 4
- BITS G529 Research Project I 6
- CE G516 Multicriteria Analysis in Engineering 3 1 4
- CE G520 Infrastructure Planning and Management 3 1 4
- CE G528 Selection of Construction Equipment and Modeling 3 1 4
- CE G538 Project Planning & Management 3 1 4
- CE G539 Introduction to Discrete Choice Theory 4*
- CE G543 Traffic Flow Theory 3 1 4
- CE G545 Airport Planning and Design 3 1 4
- CE G547 Pavement Failures, Evaluation and Rehabilitation 3 1 4
- CE G549 Rural Road Technology 3 1 4
- CE G563 Stochastic Methods in Civil Engineering 3 1 4
- CE G569 Transportation Economics 3 1 4
- CE G570 Highway Construction Technology 3 1 4
- CE G571 Road Asset Management 3 1 4
- CE G572 Transportation Data Analytics 3 1 4

- CE G573 Road Safety and Accident Analysis 3 1 4
- CE G574 Pavement Maintenance 3 1 4
- CE G575 Freight Transportation 3 1 4
- CE G616 Bridge Engineering 3 1 4
- CE G619 Finite Element Analysis 3 2 5

Core Courses:

CE G518 Pavement Analysis and Design [3 1 4]

Types of pavements, flexible, rigid and semi-rigid; components of pavement structure; stresses and strains in flexible and rigid pavements: layered systems, visco-elastic solutions; stresses and deflections in rigid pavements; computer programmes for analysis of stresses and deflections in rigid pavements; traffic loadings, load equivalency factors, traffic projections and analysis; material characterization as input to pavement design; flexible pavement design and rigid pavement design using IRC, AASHTO, PCA methods; design of overlays; pavement deterioration, pavement performance and use of HDM-4; pavement drainage design.

CE G534 Pavement Material Characterization [3 1 4]

Field and Laboratory tests on soil, stabilization techniques. Geosynthetics testing and specifications. Tests on aggregates including the quarrying, crushing, stacking and gradation. Tests on bitumen and importance of viscosity grading, tests on bitumen emulsions and application, tests on modified bitumen. Performance grading of bitumen and the rheology test as per ASTM standards. Bituminous mixture design using Marshall's and Super-Pave methods. Performance tests on bituminous mixtures such as resilient modulus, dynamic modulus, creep tests, 4-point bending fatigue test and Hamburg wheel tracking rutting test. Pavement Quality Concrete (PQC) mixture design and tests on joint filler and sealant materials. Admixtures for bituminous and cement concrete. Alternate materials such as Reclaimed Asphalt Pavement (RAP) material, fly-ash, slags and other marginal materials.

CE G565 Transportation Planning [3 1 4]

Basic concepts in transportation planning, accessibility and mobility, land use interaction, government role in transportation planning, characteristics of travel and transport problems; transportation survey and data collection: planning, design and implementation, travel analysis zone (TAZ) development, traditional four-step modelling process; analysis of travel behaviour and demand: studying travel behaviour, analysing urban travel markets; innovations in transportation modelling: travel behaviour model, activity-based models, econometric modelling using rstudio, modelling travel demand with cube, transportation demand management (TDM), transportation system management (TSM), smart city transportation planning: transit-oriented development (TOD),pedestrian-oriented development, liveable street planning, multimodal transportation planning, shared mobility concepts, integrated transportation management and planning, transportation and energy, climate change, fuel choice and green mobility.

CE G566 Public Transportation [3 1 4]

Modes of public transportation, history and classification, transit right of way, qualitative swot analysis. role of public and private sectors in mass transit. transit planning and data collection. ridership prediction, route determination, stopping policy, stop spacing determination, transit network design: capacity, way headway, station headway, safety regime, dwell time, frequency. vehicle capacity, transit operation scheduling: development of time-table and determination of fleet size; and, crew scheduling process, demand-based transit planning. fare structure and collection technology. dynamic responsive transit planning. Transit system performance measures and benchmarking. innovation in transit system technology.

CE G567 Highway Design [3 1 4]

Highway functional classification; design controls and criteria: turning paths, traffic characteristics, highway capacity aspects, access control, safety, environment; sight distances; horizontal and vertical alignments; geometric design for expressways, at grade intersections rotaries and mini roundabouts, importance of channelization and design of channelizing islands, intersection layouts; grade separated interchanges: types, layouts, suitability, advantages and limitations of different types of interchanges, performance based design, geometric design consistency; pedestrian-oriented development, liveable streets, bicycle and pedestrian planning; on street and off street parking layouts and design; layouts of truck terminals and bus bays; introduction to geometric design software. plan and profile preparation using drafting and visualization software such as AutoCAD, Micro-station. Alignment design using MXROAD, AutoCAD Civil 3D, open road; checking swept path of turning vehicles: AutoTrack, AutoTurn; Highway design manuals.

CE G568 Traffic Systems Analysis [3 1 4]

Characteristics of traffic stream: Traffic flow, speed and density, Traffic data collection. Modeling uninterrupted traffic flow: Microscopic and macroscopic modeling, Car-Following theory. Capacity and level-of-service analysis: Concepts of capacity and level-of-service (LOS) of highways, expressway, highway, multilane highway and multi-modal LOS as per latest Highway Capacity Manual (HCM). Traffic flow at Toll-Plazas: Queuing theory, delay and queue length analysis of traffic at Toll-Plazas. Traffic flow at un-signalized intersections: Gap acceptance theory and capacity estimation of traffic at un-signalized intersections. Traffic flow at signalized intersections: Delay and queue length analysis of traffic at signalized intersections, design of signals and concept of Co-ordinated signals. Adaptive signal concepts., Advanced Intelligent Transport Systems (ITS). Introduction to latest Traffic simulation packages, Exposure to relevant codes of practice.

Electives:

BITS F494 Environmental Impact Assessment [3 1 4]

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

BITS G529 Research Project I [6]

CE G516 Multicriteria Analysis in Engineering [3 1 4]

Introduction, Conventional optimization, Multi-objective Optimization, Fuzzy logic and its extensions, in multi-objective optimization, Multicriterion Decision Making, Deterministic analysis, Stochastic analysis, Fuzzy analysis, Classification problems, Hybrid approaches in Decision Making, Genetic Algorithms, Artificial Intelligence, Artifical Neural networks, Practical applications in Engineering.

CE G520 Infrastructure Planning and Management [3 1 4]

The goals and perspectives of planning; forecasting and design of alternatives; plan testing: economic, financial and environmental evaluation; the challenges of managing infrastructure; Information management and decision support system; Concepts of total quality management; Economics: life-cycle analysis and maintenance, Rehabilitation and Reconstruction (M.R & R) programming; Infrastructure management system (IMS) development and implementation; Rural Infrastructure Planning.

CE G528 Selection of Construction Equipment and Modeling [3 1 4]

Selection and application of construction and earth moving equipment; Productivity analysis of equipment operations; mathematical models for construction operations; Quality issues in construction process modeling.

CE G538 Project Planning and Management [3 1 4]

Foundations of project management: project life cycle, environment, selection, proposal, scope, ToR standardization; work break down structure; network scheduling: critical path method (CPM), programme evaluation and review technique (PERT), planning and scheduling of activity networks; resource planning: allocation, schedule compression, precedence diagram, generalized activity network; estimation of project cost, earned value analysis, monitoring project progress; quality assurance; contract administration and management; mechanization and advanced process control; quality audit; milestones, bonus and penalties; dispute resolution; capacity building and skill development..

CE G539 Introduction to Discrete Choice Theory [4*]

Introduction, element of choice process, individual preferences, behavioural choice rule, utility based choice theory; data collection techniques, stated preference (SP) survey, revealed preference (RP) survey, paradigms of choice data; discrete choice models, property of discrete choice models, Multinomial logit model; overview and structure, Nested logit model formulation; discriminant analysis, Naive Bayes classification, classification trees, classification using nearest neighbours; application of fuzzy logic and artificial neural network in discrete choice modeling.

CE G543 Traffic Flow Theory [3 1 4]

Traffic flow elements: speed, volume and density and their relationships; time-space diagrams, controlled access concept, freeway concept, system performances, measures of effectiveness; mathematical modeling; probabilistic & stochastic models of traffic flow process, discrete and continuous modeling: headways, gaps and gap acceptance; macroscopic models; car following model; queuing models; fundamentals & development of queuing processes; traffic simulation; intelligent transportation systems (ITS).

CE G545 Airport Planning and Design [3 1 4]

Air Transport structure and organization; forecasting air travel demand, trend forecasts and analytical methods; air freight demand; airport system; characteristics of the aircraft; airport capacity and configuration; airport master planning: site selection, layout plan, orientation and length of runway as per ICAO specifications; geometric design of runway taxiway and aprons; structural design of runway and taxiway pavements; airfield pavement drainage; airport runway structural evaluation using Heavy Falling Weight Deflectometer (HFWD), overlay design. Passenger terminal function, passenger and baggage flow, analysis of flow through terminals, parking configurations and apron facilities; air cargo facilities-flow through cargo terminals, airport lighting; airport access problem; environmental impact of airports.

CE G547 Pavement Failures, Evaluation and Rehabilitation [3 1 4]

Pavement deterioration, distress and different types of failures, pavement surface condition deterioration such as slipperiness, unevenness, rutting, cracking; pot holes, etc., causes, effects, methods of measurement and treatment, use of modern equipment for pavement surface condition measurements, Analysis of data, interpretation. Structural deterioration of pavements: causes, effects, methods of treatment. Structural evaluation of flexible pavements by rebound deflection method, analysis of data, design of overlay, use of FWD and other methods for evaluation of flexible and rigid pavements and their application. Evaluation of new pavement materials, model studies, pavement testing under controlled conditions, accelerated testing and evaluation methods, Test track studies. Instrumentation for pavement testing.

CE G549 Rural Road Technology [3 1 4]

Network planning, accessibility and mobility; road alignment and survey; geometric design: cross-sectional elements, sight distance, horizontal and vertical alignments; road materials and use of marginal materials; pavement design, drainage, culverts and small bridges; construction and specifications; quality control in construction; pavement failures; maintenance; preparation of detailed project report (DPR); community participation in planning, design, construction and management.

CE G563 Stochastic Methods in Civil Engineering [3 1 4]

Uncertainty, Discrete and Continuous distributions, Hypothesis testing, Classification and characteristics of time series, Autocorrelation analysis, Multivariate data analysis by logistic regression, discriminant analysis, cluster analysis, factor analysis, queuing theory, Reliability analysis, Statistical quality control, Introduction to univariate and multivariate stochastic models, markov chain and their properties, introduction to Transition probability, case studies.

CE G569 Transportation Economics [3 1 4]

Introduction to engineering economics. Transportation Demand and Supply. Transportation Cost concept. Conceptual aspects of Elasticity, Demand forecasting methods, factors influencing transport demand, direct and cross-price elasticities of demand, factors that cause shifts in demand function. Investment and financing of transport: Revenue sources; expenditure sources; traditional project delivery methods and innovation in financing. Congestion pricing. Transport project evaluation: economic appraisal; discount rate and time value of money; net present value; cost-benefit analysis and life cycle cost analysis as per IRC: SP:30. Road User Cost Study (RUCS). Feasibility and evaluation, cost, evaluation of alternatives, analysis techniques, measures of land value and consumer benefits from transportation projects, prioritization of projects.

CE G570 Highway Construction Technology [3 1 4]

Road planning and reconnaissance; right of way selection; fixing of alignment; road construction techniques: construction staking, clearing and grubbing; subgrade construction: excavation and filling, compaction, preparation of sub grade, quality control tests as per MoRT&H specifications; granular subbase and base course construction: gravel courses, WBM, WMM, stabilized soil subbases, use of geo-textiles and geo-grids; construction of bituminous layers; concrete pavement construction. Hot mix asphalt plants, road construction equipment, material placement and compaction methods, shoulders, highway drainage and roadside requirements; State of the art construction management techniques, construction standards, quality control and quality assurance including contract documents and arbitration.

CE G571 Road Asset Management [3 1 4]

Need for Road inventory data, purpose and types. Characterization of pavement performance including the concept of pavement condition index. Application of road roughness data including the calibration for universal roughness standard. The nondestructive measurement of structural condition of the pavement at network and project level. Database Management with automated survey methods for distress prediction. Pavement deterioration models, pavement maintenance and rehabilitation techniques. Life cycle cost analysis using HDM4. Prioritization of pavement maintenance strategies. Developing asset management plans: financial plan, asset valuation, resource allocation. Economic evaluation of alternative pavement design strategy and selection of an optimal maintenance strategy.

CE G572 Transportation Data Analytics [3 1 4]

Research Design Concepts in transportation, Data collection and analysis techniques. Probability Distributions, Sampling and Measurement, Interval Estimation, Hypothesis Testing, Analysis of Variance. Simple, Multiple and Time-series Regression, Dynamic Regression Models, Structural Equation Models, Count Data Models. Supervised Learning Methods: Tree-based Methods and Support Vector Machines. Clustering Methods: Dimensionality Reduction (Principal Component Analysis, Independent Component Analysis), Clustering Methods: Hierarchical clustering, K-Means Clustering, Mean Shift Clustering, Density-based Clustering. Data analysis and modelling using R-Studio. Case Studies –Traffic Operations, Pavement Materials and Quality Control, Transportation Planning, Public Transit and Road safety and Highway Geometric Design.

CE G573 Road Safety and Accident Analysis [3 1 4]

Road safety, accident statistics and investigation, collision and condition diagrams, accident data collection. Reactive and proactive measures of road safety, safe systems approach, blackspot identification and mitigation measures, development of safety performance functions, road safety audit (RSA), identification and treatment of crash locations, economic analysis of road safety measures, Application of intelligent transportation system in road safety management, Accident investigation, Introduction to Road safety manuals including IRC SP 88, PIARC Documents, AUSTROADS Documents, International Road Assessment Program (I-RAP), Network-based safety analysis, Road signs and markings and related codes, Accident Reconstruction.

CE G574 Pavement Maintenance [3 1 4]

Importance of highway maintenance works and timely rectification of defects in flexible pavements. Routine maintenance, preventive maintenance, periodic maintenance, special maintenance, emergency repairs, patching of potholes, strengthening and rehabilitation of road pavements and drainages. Causes of distress in flexible and rigid pavements, failure of surface and subsurface drainage systems. Maintenance of rural roads: Gravel roads, bituminous roads, cell filled pavements, roller compacted concrete pavement, interconnected block pavement. Maintenance of urban roads: Flexible pavements, thin and ultrathin white topping, cobble roads, interconnected block pavement, side drains and subsurface drainage layer, utility service lines. Retrofitting of dowel bars in rigid pavement.

CE G575 Freight Transportation [3 1 4]

Introduction to Freight System, Overview of three-layer structure of freight: Global, Regional and Local, Freight Transport Industry Structure: Maritime freight Transport, Air freight Transport, Road freight Transport, Rail Freight Transport. Factors affecting freight demand, Freight generation, Freight trip generation, Modelling Inter-Regional Freight Demand Models. Use of GPS and Bluetooth Data for Freight Analysis, International best practices of freight models. Freight Distribution Structures, Logistics Network Planning, Distribution centers, urban freight consolidation centers and warehouses: location, design and operation, Warehouse management and information, Material Management and Inventory Theory, Economic Order Quantity, Demand forecasting for inventory replenishment systems. Off-hour freight delivery (OHD) schemes, Freight emission modelling, Humanitarian Logistics. Relief Network Models for Efficient Disaster Management.

CE G616 Bridge Engineering [3 1 4]

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

CE G619 Finite element analysis [3 2 5]

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.